INDOOR AIR QUALITY SURVEY

3101 Park Center Drive
Alexandria, Virginia

Prepared for:

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Public Building Service, National Capital Region
301 7th Street, SW
Washington, D.C. 20407

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SUMMARY

Applied Environmental, Inc. performed a limited Indoor Air Quality (IAQ) survey on the second, fourth, and ninth floors of the office building located at 3101 Park Center Drive, in Alexandria, Virginia. The survey was performed on July 17, 2009, and consisted of direct read measurements of temperature, relative humidity, carbon monoxide (CO), carbon dioxide (CO_2), Respirable Particulate, and total Volatile Organic Compounds (VOCs).

Criteria used to evaluate the survey results include standards and guidelines referenced by the Occupational Safety and Health Administration (OSHA), the American Conference of Governmental Industrial Hygienists (ACGIH), the U.S. Environmental Protection Agency (EPA), the National Institute for Occupational Safety and Health (NIOSH), and other applicable industry guidelines.

Air quality on the second, fourth, and ninth floors of the office building located at 3101 Park Center Drive was within acceptable limits for the parameters measured. Total VOC and respirable particulate concentrations were below all applicable standards or guidelines. No excessive odors, surface dust, or construction debris were observed in occupied areas.

SITE HISTORY AND OBSERVATIONS

The 3101 Park Center Drive office building is a 14 story concrete structure with a penthouse mechanical level and four levels of underground parking. It is approximately 26 years old. The building has a cobblestone exterior, with inoperable windows. The structure contains typical office space, with interior finishing materials including gypsum board (drywall) walls, carpet or tile over concrete floors, and suspended acoustical tile ceiling systems.

A major renovation of the building's interiors has been occurring for several months. During the renovation, building occupants have remained on the floors under construction. Some building occupants have complained of excessive dust and odors.

During the survey, painting, carpet and system furniture installation, as well as drywall work, was being performed on the second floor. Carpet installation is being performed during unoccupied hours. On the fourth floor, carpet and system furniture installation was being performed. Renovations on the ninth floor had been completed, with the exception of work still being performed in one conference room.

A slight paint odor was observed on the second floor in the vicinity of a construction area where painting was being performed. No odors related to construction work were observed on the fourth or ninth floors. Minor dust accumulations were observed in some construction areas, but no excessive surface dust or construction debris was observed in areas occupied by employees of the agency.

SURVEY METHODOLOGY

Few legally enforceable standards exist governing the acceptable levels of airborne pollutants or other contaminants within a non-industrial building. Typically, interpretation of air sampling data obtained in IAQ evaluations is based on the guidelines and recommendations that have been developed for an indoor environment by various recognized technical associations and groups. These include the ACGIH, NIOSH, American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE), and the American Industrial Hygiene Association (AIHA).

Direct Read Measurements

The IAQ measurements were made with a portable air quality monitor manufactured by Metrosonics, Inc. The principle of operation for CO_2 measurement is non-dispersive infrared spectrophotometry. The unit has an accuracy tolerance within ±3% of full scale (5,000 parts per million (ppm) at 25°C) and a resolution limit of 1 ppm. It is capable of providing real time CO_2 concentration, with a range of operation from 0 to 5,000 ppm. The Metrosonics unit also measures ambient temperature with a usable range of 32°F to 140°F, with an accuracy of ±0.9°F. Ambient relative humidity is measured from 0% to 100% relative humidity, with an accuracy of ±3% at 25°C.

The CO measurements were made with a selective electrochemical sensor installed in the Metrosonics unit. The CO sensor has an accuracy (at 25°C) of better than ±3% of the reading, or ±2 ppm (whichever is greater). The unit is capable of providing real time CO concentrations during the sampling period, with a range of operation of 0 to 1,000 ppm.

Respirable particulate measurements were collected using an MIE *personal*DataRAM (Personal Data-logging, Real time Aerosol Monitor), Model pDR-1000, manufactured by Monitoring Instruments for the Environment, Inc., of Bedford, Massachusetts. The operation of this direct read instrument is based on light scattering photometry, with measurement of the intensity (irradiance) of light scattered by particles passing through the sensing area. The instrument measures both solid and liquid particles from 0.1 to 10 micrograms (μm) in size. Concentrations from 0.001 to 400 milligrams per cubic meter (mg/m^3) of air can be measured with an accuracy of ±5% of the reading. The instrument is capable data logging for up to 100 hours with appropriate internal settings, although normal battery life with constant operation is 20 hours. Before the survey, the instrument was zeroed in particle free air.

Total VOC measurements were performed using a portable Photo Ionization Detector (PID), manufactured by Photovac, Inc. A PID measures the concentration of airborne ionizable gases and vapors, with measurement reported in ppm of VOCs. The Photovac PID uses an inlet flow

rate of approximately 200 milliliters per minute (ml/min) and is capable of providing real time total ionizable VOC concentrations in a range of operation from 0.5 ppm to 2,000 ppm (isobutylene equivalent). It is equipped with a 10.6 eV ultraviolet light source that generates photons able to ionize certain molecules in the gas stream. The PID is calibrated to a standard of 100 ppm of isobutylene. Its accuracy is 10% of the reading, or ±2 ppm, whichever is greater. Isobutylene produces a medium range response in the instrument, making it a reliable standard for use when measuring average concentrations of total ionizable VOCs in sampled air. A PID does not identify specific chemical species.

SURVEY FINDINGS

A discussion of each sampling parameter and the results are presented below. A data table indicating the locations of the direct read measurements and the results is included as Appendix A.

Carbon Dioxide

Carbon dioxide a product of combustion and human respiration, and is a commonly used indicator of overall air quality and ventilation rates within an occupied building. The levels found in buildings are primarily a function of the rate and amount of outdoor air delivery to the occupied space, the effectiveness of air distribution within the space, and the occupancy (number of people and activity) of the space. It is generally accepted that an inadequate outdoor air supply may cause problems such as headaches and respiratory difficulties, due to a general build-up of non-specific contaminants and odors. These symptoms are typically categorized as "Sick Building Syndrome."

ASHRAE has published a recommended guideline of 700 ppm of CO_2 above the ambient outdoor concentration as the maximum limit for acceptable air quality in their document, *ASHRAE 62.1-2007, Ventilation for Acceptable Indoor Air Quality*. At a differential less than 700 ppm, 80% of unadapted individuals (visitors) would find air quality acceptable (based upon non-specific contaminants, such as body odor and other bioeffluents).

According to the *OSHA Technical Manual, Section III, Chapter 2 - Indoor Air Quality Investigation* (a non-regulatory guidance document issued by *OSHA Directive TED 01-00-015, January 20, 1999*, for OSHA personnel conducting field surveys), NIOSH has published the following guidelines for indoor levels in their document, *Guidance for Indoor Air Quality Investigations, 1987*:

"250-350 ppm	Normal Ambient Outdoor Concentrations
600 ppm	Minimal Air Quality Complaints
600 – 1,000 ppm	Less Clearly Interpreted
1,000 ppm	Indicates inadequate ventilation and complaints such as headaches, fatigue, and eye and throat irritation will be more widespread; 1,000 ppm should be used as an upper limit for indoor levels

These levels are only guidelines. If carbon dioxide levels exceed 1,000 ppm it does not necessarily indicate that the building is hazardous and should be evacuated. Rather this level should be used as a guideline that helps maximize comfort for all occupants."

Carbon dioxide concentrations measured indoors ranged from 496 ppm to 693 ppm, and were well below the recommended maximum concentrations referenced above. Outdoor concentrations during the survey ranged from 422 ppm to 458 ppm.

Carbon Monoxide

Carbon monoxide is a colorless, odorless, and tasteless gas formed during the combustion of hydrocarbon fuels. It is often encountered in garages and loading dock areas, and can be introduced into buildings by way of the ventilation system. Carbon monoxide is a simple asphyxiant to humans; when inhaled it combines with the hemoglobin of the blood to prevent oxygen transportation to the brain, heart, and other body parts. Prolonged exposure to CO can cause severe heart, brain, and circulatory damage.

Current OSHA exposure limits are 50 ppm for an 8-hour Permissible Exposure Limit (PEL). OSHA has proposed a Time-Weighted Average (TWA) exposure limit of 35 ppm, and a ceiling level of 200 ppm, with an Immediately Dangerous to Life and Health (IDLH) level of 1,200 ppm. The ASHRAE guideline for CO is 9 ppm as an 8-hour TWA, or 35 ppm as a 1-hour TWA.

Carbon monoxide concentrations measured during the survey were 0 ppm (undetectable) in all locations, and were well below the referenced guidelines. Outdoor concentrations were also 0 ppm.

Temperature and Relative Humidity

The standard, *ASHRAE 55-2004, Thermal Environmental Conditions for Human Occupancy*, recommends that indoor temperatures be maintained between 73°F and 79°F during the summer/transitional season, and between 68°F and 74°F during the winter/transitional season. These values are considered acceptable ranges of operative temperature and humidity for persons wearing typical light clothing and engaged in light activity, such as in a typical office setting. The standard is considered to be met if 80% of the building occupants are satisfied. The OSHA Technical Manual references a comfort range from 68°F to 76°F.

ASHRAE 62.1-2007, Ventilation for Acceptable Indoor Air Quality, recommends that indoor relative humidity be maintained below 65%. OSHA recommends humidity control within a 20% to 60% range in their technical manual for IAQ investigations. Low relative humidity can result in eye irritation and complaints of nose and throat discomfort. In addition, irritated mucous membranes can predispose susceptible individuals to the effects of certain chemical and microbiological air contaminants. High humidity levels (over 70%) can promote the growth of microorganisms on building surfaces and furnishings, and cause or contribute to microbial IAQ problems.

The Washington, D.C. metropolitan area commonly experiences hot summers with high humidity, and cold winters with very low humidity. Excessive humidity is typically controlled indoors by the air conditioning system, and is generally within the referenced comfort ranges during the cooling season. Low indoor humidity levels in the winter are caused by drawing low humidity outdoor air into the heating, ventilation, and air conditioning system and heating it to the desired comfort level. This heating process drives moisture out of the conditioned air, commonly resulting in depressed humidity levels indoors during the heating season. Target operating temperatures in commercial buildings in the Washington, D.C. metropolitan area range from 69°F to 74°F, with indoor relative humidity levels ranging from approximately 35% to 55% during the cooling season, and from 20% to 40% during the heating season.

Temperatures measured on the second and fourth floors ranged from 71.1°F to 74.4°F, and were below the ASHRAE recommended comfort range for the summer months in many locations. However, all temperatures were within the comfort range referenced in the OSHA Technical Manual. Temperatures on the ninth floor ranged from 73.1°F to 76.3°F, and exceeded the OSHA recommended range in two locations. However, all temperatures on the floor were within the ASHRAE recommended range.

Relative humidity on all floors ranged from 42.8% to 58.9%, and was within the recommended range. Outdoor temperatures during the survey ranged from 80.1°F to 88.3°F, with relative humidity ranging from 47.4% to 62.3%.

Respirable Particulate

Respirable particulate, which includes combustion products such as cigarette smoke, may cause irritation of the respiratory tract in individuals exposed to excessive concentrations. ASHRAE has adopted the World Health Organization consensus guidelines, and recommends a level of concern of more than 150 micrograms per cubic meter ($\mu g/m^3$) for short-term exposure to respirable particulate generated from tobacco smoke. Short-term exposure to levels below 100 $\mu g/m^3$ of respirable particulate is considered to be of limited to no concern.

Respirable nuisance dust is the fraction of the total airborne concentration of dust particles that are within the respirable range, and would be deposited in the lungs. Respirable particulate not otherwise classified (i.e., not having a specific standard or PEL associated with the material) has an OSHA PEL of 5 mg/m^3 (5,000 $\mu g/m^3$) as an 8-hour TWA.

The concentrations of respirable particulate ranged from 4 $\mu g/m^3$ to 24 $\mu g/m^3$. These concentrations are well below the referenced limits.

Volatile Organic Compounds

The term "hydrocarbons" refers to a broad category of organic chemical materials consisting of carbon and hydrogen containing molecules; the most well known of which are solvents such as toluene, xylene, chlorinated alkenes, and benzene compounds. Volatile hydrocarbons are present in buildings as off-gassing products from construction materials, carpets, and furnishings, as well

as cleaning agents, copying processes, photographic laboratories, graphics studios, and cafeterias (cooking). Recent research has also implicated ventilation systems as sources of VOCs. It should be noted that over 500 specific VOCs have been isolated in office air sampling studies (including buildings in which there were no occupant complaints).

There are no current federal standards or recommended guidelines for total hydrocarbons or VOCs in air, since such a measure represents a mixture of compounds. In 2002, ASHRAE proposed that total hydrocarbon levels in office environments should be maintained below 3 mg/m^3 (1.3 ppm using isobutylene).

Total VOC concentrations measured during the survey ranged from 0.0 ppm (undetectable) to 0.6 ppm and were below the ASHRAE recommendation and any other applicable standard.

CONCLUSIONS

The results of this survey indicate that air quality on the surveyed floors was within acceptable limits for the parameters measured. Total VOC and respirable particulate concentrations were below all applicable standards or guidelines. No excessive surface dust or odors related to the renovation project were observed.

APPENDIX A

Direct Read Monitoring Results

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Alexandria, Virginia

July 17, 2009

DIRECT READ RESULTS

Sampling Location	Time	Carbon Dioxide CO_2 (ppm)	Relative Humidity (%)	Temperature (°F)	Carbon Monoxide CO (ppm)	Respirable Particulate ($\mu g/m^3$)
Outdoor	9:15 a.m. 1:46 p.m.	458 422	62.3 47.4	80.1 88.3	0 0	-- --
Ninth floor Exterior office, room 906-K	9:43 a.m. 2:00 p.m.	632 591	47.9 42.8	74.9 75.3	0 0	10 12
Ninth floor Interior office, room 906-L	9:46 a.m. 2:03 p.m.	637 582	49.9 43.7	74.1 74.2	0 0	11 5
Ninth floor Interior office, room 906-P	9:49 a.m. 2:06 p.m.	596 581	54.3 45.9	73.6 75.3	0 0	15 7
Ninth floor Cubicle area, T. Rodgers cubicle	9:52 a.m. 2:09 p.m.	658 596	52.0 46.3	73.5 75.5	0 0	14 4
Ninth floor Exterior office, room 914	9:55 a.m. 2:12 p.m.	624 631	51.1 46.7	73.5 76.3	0 0	10 8
Ninth floor Exterior office, room 926	9:58 a.m. 2:15 p.m.	591 618	49.3 47.7	73.7 76.2	0 0	9 13
Ninth floor Common area, near room 936	10:01 a.m. 2:18 p.m.	629 587	51.0 47.6	73.6 75.8	0 0	11 5
Ninth floor Common area, near room 942-B	10:04 a.m. 2:21 p.m.	643 661	50.4 49.2	73.7 75.7	0 0	8 6
Ninth floor Interior office, room 942-E	10:07 a.m. 2:24 p.m.	613 621	51.0 48.9	73.1 75.1	0 0	18 6

ppm = parts per million
$\mu g/m^3$ = micrograms per cubic meter

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Sampling Location	Time	Carbon Dioxide CO_2 (ppm)	Relative Humidity (%)	Temperature (°F)	Carbon Monoxide CO (ppm)	Respirable Particulate ($\mu g/m^3$)
Ninth floor Suite 900, reception area	10:10 a.m. 2:27 p.m.	602 653	51.7 50.9	73.4 74.6	0 0	13 7
Ninth floor Exterior office, room 906-H	10:13 a.m. 2:30 p.m.	612 601	51.8 50.3	73.6 74.8	0 0	12 9
Fourth floor Common area, training room	10:21 a.m. 2:35 p.m.	561 543	51.9 52.1	72.2 74.0	0 0	10 21
Fourth floor Exterior office, Southwest corner office	10:24 a.m. 2:38 p.m.	521 515	56.2 58.7	72.4 73.7	0 0	18 15
Fourth floor Common area, J. Flavin	10:27 a.m. 2:41 p.m.	561 496	55.8 58.2	72.8 74.4	0 0	21 18
Fourth floor Cubicle area, near A. Ford Cubicle	10:30 a.m. 2:44 p.m.	539 542	55.2 58.7	73.1 74.4	0 0	24 17
Fourth floor Reception area, near room 400-B	10:33 a.m. 2:47 p.m.	542 537	54.4 58.2	72.8 73.6	0 0	17 18
Fourth floor Exterior office, room 400-A	10:36 a.m. 2:50 p.m.	507 543	55.4 58.3	72.4 73.3	0 0	19 20
Fourth floor Cubicle area, S. Testerman cubicle	10:39 a.m. 2:53 p.m.	519 517	55.4 58.9	71.9 72.4	0 0	16 21
Fourth floor, cubicle area Near C. Miller cubicle	10:42 a.m. 2:56 a.m.	523 564	57.1 58.8	72.4 72.6	0 0	21 17

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Sampling Location	Time	Carbon Dioxide CO_2 (ppm)	Relative Humidity (%)	Temperature (°F)	Carbon Monoxide CO (ppm)	Respirable Particulate ($\mu g/m^3$)
Fourth floor Exterior office, room 408	10:45 a.m. 2:59 p.m.	509 594	57.5 58.6	72.9 73.0	0 0	18 19
Fourth floor Interior office, room 406	10:48 a.m. 3:02 p.m.	532 541	58.5 58.1	72.9 73.1	0 0	22 21
Second floor Interior office, room 204-A	10:54 a.m. 3:07 p.m.	616 619	48.1 49.2	72.8 73.1	0 0	12 9
Second floor Common area, near J. Bausch cubicle	10:57 a.m. 3:10 p.m.	614 602	48.2 48.9	72.5 72.1	0 0	11 19
Second floor Exterior office, room 211	11:00 a.m. 3:13 p.m.	658 591	46.2 48.3	73.6 72.7	0 0	12 9
Second floor Exterior office, room 220	11:03 a.m. 3:16 p.m.	593 651	46.1 48.9	73.8 72.7	0 0	17 13
Second floor Cubicle area, near M. Cleveland cubicle	11:06 a.m. 3:19 p.m.	584 612	46.3 48.2	72.7 72.3	0 0	12 13
Second floor Exterior office, room 222	11:09 a.m. 3:22 p.m.	586 578	47.9 48.4	72.0 72.1	0 0	16 18
Second floor Fitness Center, room 230, aerobic room	11:12 a.m. 3:25 p.m.	586 561	48.6 49.8	71.3 71.1	0 0	10 17
Second floor Room 232, reception area	11:15 a.m. 3:28 p.m.	676 595	50.5 51.5	73.1 72.8	0 0	16 15

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Sampling Location	Time	Carbon Dioxide CO_2 (ppm)	Relative Humidity (%)	Temperature (°F)	Carbon Monoxide CO (ppm)	Respirable Particulate ($\mu g/m^3$)
Second floor	11:18 a.m.	693	48.1	73.9	0	9
Mail room, central	3:31 p.m.	652	48.0	73.3	0	12
Second floor	11:21 a.m.	605	46.2	73.3	0	12
Common area, near room 210	3:34 p.m.	598	47.3	72.8	0	13

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